MOTION

→ The phenomena of change of position of an object.

→

→ State of rest and state of motion are the two states in physics.

→ Physics is the heart of science and it is branch of science that deals with study of natural phenomena.

ex- flowing of air, any event around us.

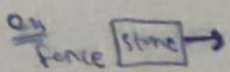
→ Physical quantity (or) parameters → These quantity which we can measured.

Light is not a physical quantity as we can't measure light but we can measure intensity of light and wavelength.

→ Physical quantity is of two types → scalar quantity, vector quantity.

(magnitude alone) (Length, mass, Temp)

described by (magnitude & direction).



→ Representation of vector ($\vec{V}$) and scalar (M).

→ without unit physical quantity don't have any meaning.

ex Mass 50kg., Height → 175cm.
→ unit.

→ unit → it is a reference standard in terms of which any given physical quantity can be measured.

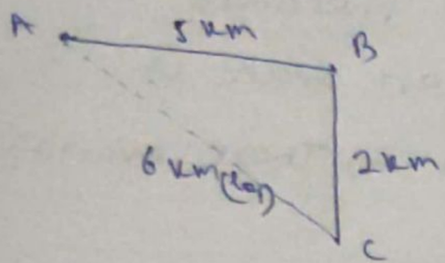
→ SI unit system ⇒ MKS, CGS, F.P.S

Length Mass Time
↓ ↓ ↓
meter kg sec

→ <u>Mechanics</u> → It is the branch of physics which deals with study of motion objects.

→ Now we will study the physical quantity related to motion i.e. distance, displacement, distance, Acceleration, uniform & non uniform motion etc.

<u>Distance</u> → Total actual path covered by body.



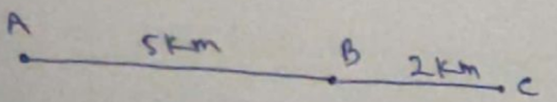
distance = 5 + 2 = 7 km
displacement = 6 km.

<u>Displacement</u> → The shortest separation bet^n initial & final position.

<u>Units</u> → SI unit (meter).

→ distance → scalar
displacement → vector.

<u>ex</u>



distance = 7 km, displacement = 7 km.

in above two cases difference is direction.

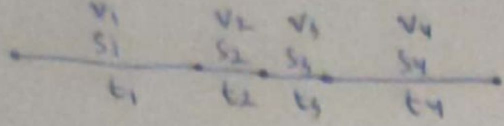
→ distance can't be zero but displacement can be zero.

→ Due to change of direction the quantity which don't change is distance (so it is scalar) but displace changes (it depends on direction) so it is vector.

<u>Speed</u> (v)	<u>Vector</u> ($\vec{v}$)
→ $v = \frac{\text{distance}}{\text{Time}}$ (m/s) ↙ (scalar)	→ $\vec{v} = \frac{\text{displacement}}{\text{Time}}$ (m/s).

Avg speed & Avg velo →

→ when things are happens in parts we find avg.



$$\text{Avg. speed} = \frac{\text{Total distance covered}}{\text{Total time}} = \frac{s_1+s_2+s_3+s_4}{t_1+t_2+t_3+t_4}$$

$$\text{Avg. velocity} = \frac{v_1+v_2+v_3+v_4}{4}$$

Uniform motion & non uniform motion :-

→ speed const → uniform (rotation of earth)

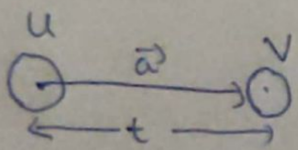
→ speed variable → Non uniform motion.

→ If an object covers equal distances in equal intervals of time then motion is uniform.

→ If an object covers ~~[illegible]~~ different (unequal) distances in equal intervals of time then motion is non uniform.

Acceleration ($\vec{a}$) :-

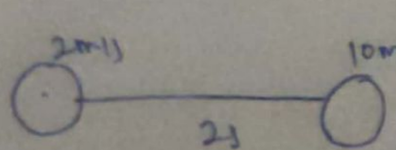
→ when there is non uniform motion i.e. the rate at which velocity changes.



$$\vec{a} = \frac{\vec{v} - \vec{u}}{t} \quad \begin{matrix} \to \text{vector} \\ \to \text{scalar} \end{matrix} = m/s^2$$

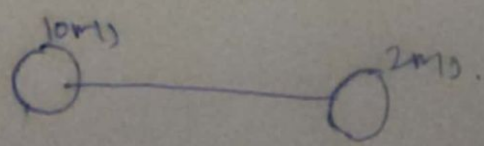
↳ vector.

eg



$$a = \frac{10-2}{2} = +4\ m/s^2$$

(Acceleration)



$$a = \frac{2-10}{2} = -4\ m/s^2$$

(retardation).

→

Motion

Uniform
(speed const.)

speed = $\frac{\text{Distance}}{\text{Time}}$

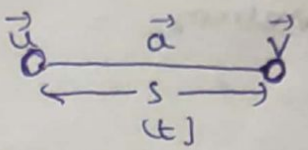
$a = 0$

Non-uniform

speed ≠ constant

Acceleration same value

→ $v = u + at$
→ $s = ut + \frac{1}{2}at^2$
→ $v^2 - u^2 = 2as$



→ Let we have a object which is moving with initial velocity ($\vec{u}$), accelerated with $\vec{a}$ to a velocity ($\vec{v}$), let t time taken to change velocity from $\vec{u}$ to $\vec{v}$ and during that period distance travel is s i.e. displacement.

→ By definition of acce.

$$a = \frac{\text{change of velocity}}{\text{time}} = \frac{v-u}{t}$$

$$\Rightarrow at = v - u$$

$$\Rightarrow \boxed{v = u + at} \quad \text{—— (I)}$$

→ By definition of velocity.

$$\text{vel} = \frac{\text{displacement}}{\text{time}}$$

(Avg. velocity)

$$\Rightarrow \frac{u+v}{2} = \frac{s}{t}$$

$$\Rightarrow s = \left(\frac{u+v}{2}\right)t$$

v from eq (I)

$$\Rightarrow s = \left\{\frac{u + (u+at)}{2}\right\}t$$

$$\Rightarrow s = \left(\frac{2u + at}{2}\right)t$$

$$\Rightarrow s = \frac{2ut}{2} + \frac{at^2}{2}$$

$$\Rightarrow \boxed{s = ut + \frac{1}{2}at^2} \quad \text{—— (II)}$$

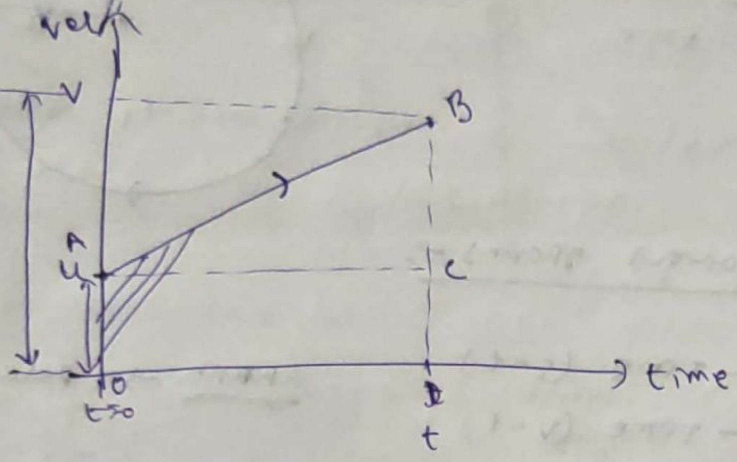
we know, $a = \frac{v-u}{t} \Rightarrow t = \frac{v-u}{a}$.

so, $s = \left(\frac{u+v}{2}\right)\left(\frac{v-u}{a}\right)$

$\Rightarrow$ $\boxed{2as = v^2 - u^2}$ —— (iii)

Graphical method →

→ 3 graphs → s-t, v-t, a-t.



→ At t=0, object velocity is u.

→ Area under vel-time graph gives displacement.

→ $Acce = a = \frac{\text{change of vel.}}{\text{time}} = \frac{BD - AO}{OD} = \frac{v-u}{t}$

$\Rightarrow at = v - u$

$\Rightarrow$ $\boxed{v = u + at}$ —— (i)

→ In vel.-time graph,

s = Area (trapezium ABDO)

= $\frac{1}{2}$ x (sum of ||el side) x Height

= $\frac{1}{2}(AO + BD)\, OD$

= $\frac{1}{2}(u+v)\,t$.

= $\frac{1}{2}(u + u + at)\,t$

= $\frac{1}{2}(2ut + at^2)$

$\Rightarrow$ $\boxed{s = ut + \frac{1}{2}at^2}$ —— (ii)

Again,

$s = \frac{1}{2}(u+v)\frac{(v-u)}{a}$

$\Rightarrow$ $\boxed{2as = v^2 - u^2}$ —— (iii)

→ Circular motion :-

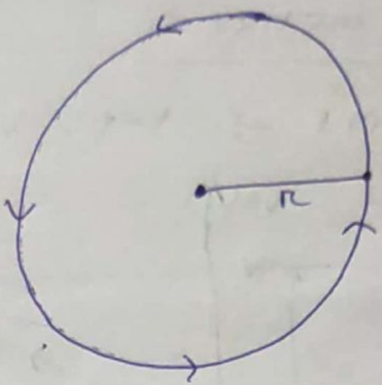
→ Motion of an object in a circular path (or) motion of an object on circumference of a circle.

→ Uniform circular motion :-

If a body moves with uniform speed in a circular path.

→ distance = $2\pi r$

→ $v = \frac{2\pi r}{T}$ (T → time.)

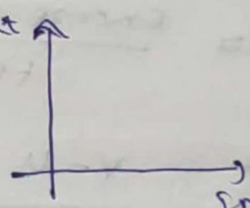


Understanding various graphs :-

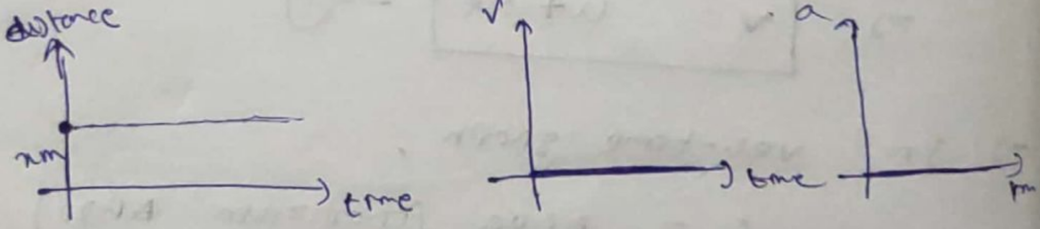
→ position - Time (s-t)
velocity - Time (v-t)
Acce - Time (a-t)

graph → relation & dependency.

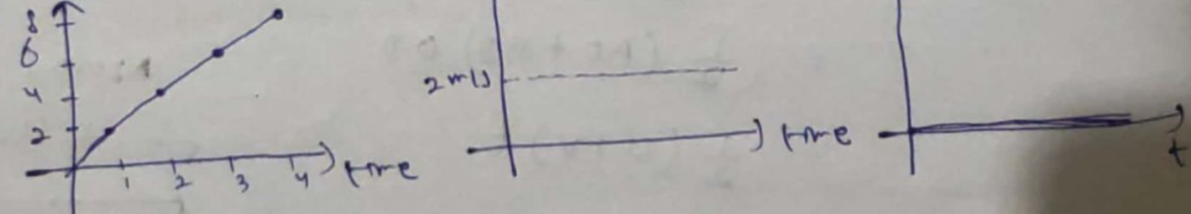
→ In x-axis we take time because it is independent of others.



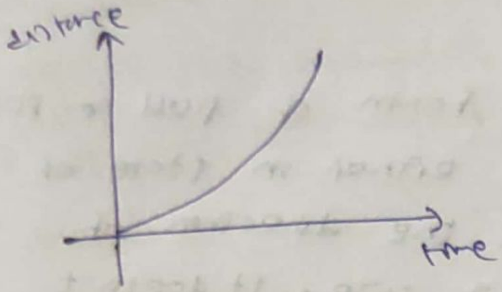
→ Body at rest :-

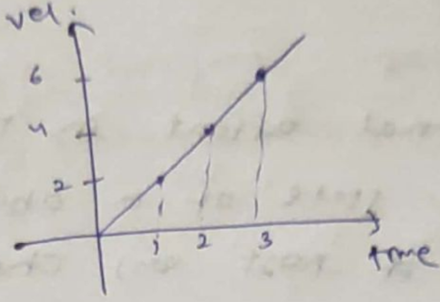


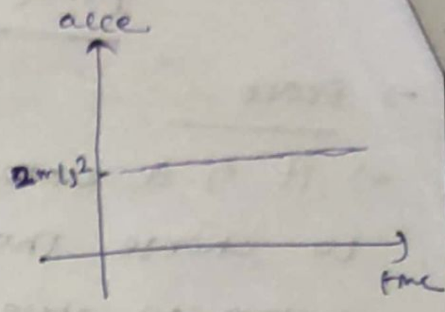
→ uniform motion →
(let speed 2m/s)



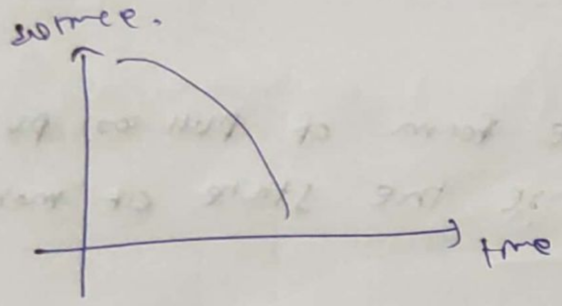
→ uniformly accelerated motion :- $a = const = 2\,m/s^2$

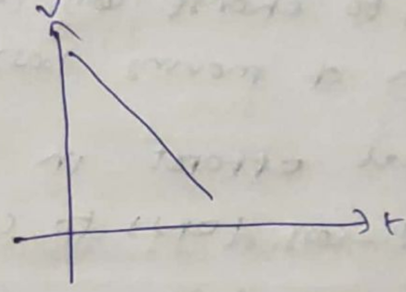


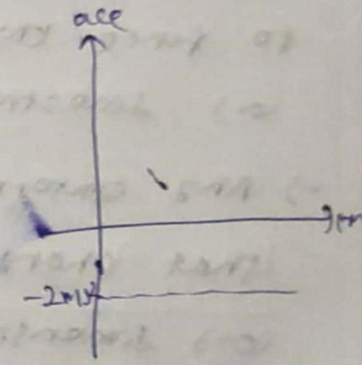




→ uniform retardation :- $a = -2\,m/s^2$.



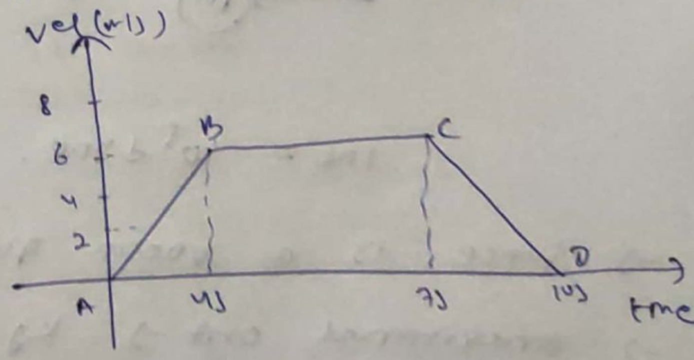




Q:- The motion of an object is given by,

At A → rest, D → rest

Here
AB → Accelerated motion.
BC → uniform motion.
CD → retardation motion.



Acce. in AB, $a = \frac{6-0}{4sec}$

$= \frac{6}{4} = 1.5\,m/s^2$

→